Fisheries and Hard Rock Mining

Symposium Abstract Text: As human population expands so does demand for renewable and nonrenewable resources. Human activities are linked to widespread extinction of North American freshwater fishes; primary causal factors are habitat destruction and degradation. About 39 percent of 1,200 described North American inland fishes are imperiled and current extinction rate averages about 5.5 taxa per decade since 1890. Demand for fish as a protein and recreational resource is expanding and sustainability of fish resources depends on balancing their essential habitat needs with competing land and water uses, such as metal mining.

Metals serve important functions in technology, industry and everyday use. However, metal mining can raise sustainability issues relative to fisheries. Metal extraction and processing requires landscape alteration, copious amounts of freshwater, and long-term or perpetual waste storage and treatment. Biologists focused on balancing fisheries and metal mining requirements are often challenged to assess risks, predict impacts, avoid and/or mitigate impacts, and implement monitoring programs, often with limited information.

The purpose of this symposium is to encourage biologists involved in fisheries and metal mining issues to share their knowledge and experiences, especially in relation to:

• Case studies illustrating mine developments compatible and incompatible with fisheries sustainability
• Essential baseline data for impact prediction and mitigation
• Risk Assessments
• Metals toxicity
• Development of long term monitoring programs
• What is a "low risk" versus "high risk" mineral development relative to fisheries
• Successful and unsuccessful mitigation for fish habitat loss

Various aspects of how mining can impact fisheries will be discussed including: what we need to know about fish habitat, biointegrity, hydrology,

water chemistry, toxicology, metals impacts on fish, monitoring, ecosystems, pollution indices, metals bioavailability and how to minimize or avoid impacts to fisheries. The question of whether fisheries and mining is compatible and what conditions must be met to determine compatibility will be addressed.

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Abstract id# 7949

Metal Mining Effects On Aquatic Biota: North American and South American Examples and Perspectives

Robert M. Hughes, PhD, Amnis Opes Institute, Corvallis, OR, Nabor Moya, PhD., Unidad de Limnología y Recursos Acuáticos, Universidad Mayor de San Simón, Cochabamba, Bolivia and Miriam Castro, B.Sc., Laboratório de Ecologia de Peixes, Departamento de Biologia, Universidade Federal de Lavras, Lavras, Brazil

Abstract Text:
Metals have been crucial components of cultures for millenia, but their acquisition and use have multiple undesirable side effects. In this talk, we focus on how metal mining has affected fish, macroinvertebrate, or both assemblages through use of case studies of mines in Montana (USA), Minas Gerais (Brasil), and the High Andes (Bolivia). Observed effects include reduced multimetric index scores, shifts from sensitive to tolerant taxa, reduced taxa richness, and reduced salmonid catch per unit effort. We conclude that existing mining laws are inadequate for protecting or rehabilitating aquatic ecosystems.

Abstract id# 4829
Water Quality and Fisheries Impacts of Mining In the North Fork Coeur D'alene River Subbasin, Idaho

Kajsa E. Stromberg, Idaho Department of Environmental Quality, Coeur d'Alene, ID

Abstract id# 5009
Start Time: 4:20 AM
Fish Presence and Water Quality In a Proposed Copper Mining District, Alaska

Sarah L. O'Neal, Fisheries Research and Consulting, Anchorage, AK and Kendra Zamzow, PhD, Center for Science and Public Participation, Sutton, AK

Abstract Text:
Bristol Bay supports the largest, most valuable salmon fisheries in the US,

and is the last major watershed in North America producing historic numbers of wild sockeye salmon. However, industrial mining interests have claimed 2,054 km^2 in these habitats, threatening two of Bristol Bay's largest salmon producing drainages, the Kvichak and Nushagak. If proposed sulfide mining occurs, the preponderance of peer-reviewed evidence indicates significant risks to fisheries due to metals contamination, habitat degradation and habitat loss.

Since 2008, independent scientists have been conducting water chemistry, habitat, and fish surveys in headwaters of the proposed mining area. Data indicate salmon presence in 3 of every 4 headwater streams surveyed. Non-salmon species important to subsistence and sportfishing stakeholders, including Dolly Varden and rainbow trout, were found in 93% of streams surveyed. Waters supporting these fish populations are important due to their purity and the exchange between ground- and surface waters. Although salmon preferentially use groundwater-fed sites for spawning, actual groundwater locations remain unmapped; here, we tentatively identify groundwater influence based on water chemistry. Stream waters are pure, with high dissolved oxygen, very low conductivity and metals concentrations, and neutral pH. Low alkalinity indicates little buffering capacity, while low dissolved organic carbon suggests metals released due to landscape disturbance from mining would remain bioavailable, degrading stream chemistry for fish.

This study underscores both the importance of headwater streams as essential salmon rearing habitat and the lack of data for two of the world's most productive salmon ecosystems. The fish survey work provides some legal protections to 149 km of newly documented salmon streams in and near proposed mine claims. Water quality studies suggest waters are pure with low buffering capacity and therefore susceptible to potential acid mine drainage and increased metals from sulfide ore mining. Future analysis will integrate physical and biological data in order to evaluate baseline biodiversity and productivity in this important region.

Abstract id# 4878
Bristol Bay Salmon and Proposed Copper Mining: Risks to Fisheries

Carol Ann Woody, PhD, Fisheries Research and Consulting, Anchorage, AK

Abstract id# 4844
Start Time: 5:20 AM
Using Otolith Microchemistry as a Proxy for the Environmental Effects of Metal Mining

Lisa A. Friedrich, PhD, Centre for Environmental Research on Pesticides, Department of Fisheries and Oceans, Winnipeg, MB, Canada

Abstract id# 4881
Integrating Sublethal Copper Neurotoxicity In Coho Salmon Across Scales of Biological Complexity

Jenifer McIntyre, PhD, LID Stormwater Program, WSU Puyallup Research & Extension Service, Seattle, WA

Abstract id# 4993
Start Time: 3:40 AM
Toxicological Effects of Copper on Behavior, Neuroanatomy, and Neurophysiology of Salmon

James A. Hansen, PhD, Dept. of Energy, Richland, WA

Abstract id# 4988
Start Time: 3:00 AM
Avoidance of Salmonids to Copper: Does the BLM-Based Water Quality Criteria Provide Protection?

William J. Adams, Dr., Rio Tinto, Salt Lake City, UT

Abstract id# 4990
Start Time: 3:20 AM
Challenges for Implementation of Copper Aquatic Life Criteria Using the Biotic Ligand Model: What Are We Waiting for?

Robert W. Gensemer, PhD[1], Stephanie Baker[1], Steve Canton[1] and

Joseph W. Gorsuch[2], (1)GEI Consultants, Denver, CO, (2)Copper Development Association Inc., New York, NY

Abstract Text:

The USEPA released their latest national guidance for development of copper aquatic life criteria in 2007. These freshwater criteria are derived using the Biotic Ligand Model (BLM) as a replacement for the hardness-based criteria equations currently used in water quality standards by almost all states. The BLM is a computational model that incorporates chemical reaction equations with the binding of metals to organism tissues responsible for causing toxicity (termed the "biotic ligand", such as a fish gill) to better represent the complex chemical factors that influence copper bioavailability. The BLM generates instantaneous freshwater criteria (acute and chronic) using 10 water quality input parameters: temperature, pH, and concentrations of dissolved organic carbon (DOC), calcium, magnesium, sodium, potassium, sulfate, chloride, and alkalinity. The BLM represents a significant scientific advancement that derives more accurate criteria which are much less likely to be significantly over- or under-protective of aquatic life. BLMs have also been developed for several other metals (e.g., nickel, zinc, and silver); these models will likely form the basis of criteria for metals other than copper in the future. However, only one state has formally adopted the BLM for use in setting water quality standards; a few other states have adopted the BLM as a tool for generating site-specific standards. We will explore the scientific and regulatory challenges that may be forming barriers to adopting BLM-based copper criteria. Scientific challenges include the potentially limited availability of data for all of the BLM parameters and variability in BLM parameter concentrations over time. This temporal variability in water quality is not unique to BLM parameters, but 10 parameters vary in more complex ways compared to hardness. Thus, successful implementation will ultimately require decisions to be made as to the number and location of water quality samples needed to adequately characterize a particular water body. Regulatory challenges include educating stakeholders on the basis of BLM-based criteria, the need for further development and review of implementation guidelines, and addressing developing concerns over the protection of salmonid fishes from copper-induced olfactory

impairment. We conclude that these challenges can be met and recommend that states move toward implementation of BLM-based criteria to improve the accuracy of aquatic life protection from copper, thereby minimizing unnecessary 303(d) listings and the need for Total Maximum Daily Loads (TMDLs) where copper impairment is unlikely.

Abstract id# 5002
Start Time: 4:00 AM
Protectiveness of Water Quality Criteria for Copper In Western United States Waters Relative to Olfactory Responses In Pacific Salmon

David K. DeForest, Windward Environmental, Seattle, WA, Robert W. Gensemer, PhD, GEI Consultants, Denver, CO, Eric J. Van Genderen, PhD, International Zinc Association, Durham, NC and Joseph W. Gorsuch, Copper Development Association Inc., New York, NY

Abstract Text:
At elevated levels copper (Cu) can impair olfaction in salmonid fishes, thus inhibiting the ability of salmonids to avoid elevated Cu concentrations and/or predators. Several salmonid species are listed as threatened or endangered in the western US, including many in urban watersheds. Because Cu is commonly elevated in stormwater runoff in urban environments, storm events may result in elevated Cu concentrations in salmon-bearing streams. Accordingly, there is concern that existing Cu criteria, which were not derived using data for olfactory-related endpoints, may not be adequately protective of salmonids. However, a reparameterized olfactory-based biotic ligand model (BLM) was recently proposed as a modification of the US Environmental Protection Agency's ionoregulatory-based BLM for deriving site-specific Cu criteria. This revision, based on olfactory inhibition in coho salmon (*Oncorhynchus kisutch*) exposed to Cu in various combinations of pH, hardness, alkalinity, and dissolved organic carbon (DOC) levels, was used to derive Cu IC20 values for 133 stream locations in the western US. The olfactory BLM-based criteria were compared to the existing hardness-based Cu criteria for western US states and the USEPA's BLM-based Cu criteria. Of the 133 sampling locations, hardness-dependent acute and chronic Cu criteria

were below the olfactory BLM-based IC20 in 124 (93%) and 130 (98%) of the waters, respectively (i.e., <20% olfactory impairment would have been predicted at the hardness-based Cu criteria concentrations). Waters characterized by high hardness and very low DOC are most likely to have hardness-based Cu criteria that are not lower than the olfactory-based IC20, as DOC strongly influences Cu bioavailability in the BLM. In all waters the USEPA's current BLM-based criteria were less than the olfactory-based IC20 values, indicating that adoption of the USEPA's BLM-based criteria by western states should ensure protection of salmonids from olfactory impairment.

Abstract id# 4812
Mine Waste Disposal In Waters of the United States

David M. Chambers, PhD, Center for Public Participation in Science, Bozeman, MT

Abstract id# 5387
"Mine Waste and Water Management – Engineering Design Considerations for Mitigating Negative Impacts to Fisheries"

Ken J. Brouwer, Knight Piesold Ltd.

Abstract id# 5317
Comparison of Predicted and Actual Water Quality at Hard Rock Mines

Ann S. Maest, PhD, Geochmistry, Stratus Consulting, Boulder, CO

Abstract id# 4833
Cleaning up After Mother Nature- the Red Dog Mine Experience

Jon Houghton, Natural Resources Group of Hart Crowser, Inc., Pentec Environmental, Edmonds, WA

Abstract id# 5377
Restoring Trout Habitat In a Landscape of Western Abandoned Mines

Pam Elkovich, Trout Unlimited, Boise, ID and Rob Roberts, Trout Unlimited, Misssoula, MT

Abstract Text:
According to the Environmental Protection Agency (EPA), abandoned hard rock mines affect 40 percent of headwaters in the western United States. The tens of thousands of abandoned mines and tailings piles are the residue of 150 years of hard rock mining under an antiquated system that encouraged minerals development but left little in the way of environmental protection. In 2003, Trout Unlimited launched a campaign to address this long standing legacy of mining impacts and initiated clean-up efforts at sites in Idaho, Colorado, Utah and Montana.

Working with the Forest Service, Bureau of Land Management, state agencies and conservation partners, TU staff have spearheaded varied mine cleanup projects in the last decade. By treating water quality from draining adits, removing mine tailings, and improve fish passage, floodplain connectivity, and suppressed vegetation communities, these restoration and reclamation project have targeted sensitive native trout species such as westslope cutthroat, bull trout, redband rainbow trout, as well as numerous other aquatic organisms.

Besides describing the legal, funding and partnership mechanisms used to complete these projects, this presentation will put an extra emphasis on the habitat and water quality issues created by historic dredge mines in Idaho and Montana. Dredge, hydraulic and placer mining was ubiquitous throughout the western U.S in the early twentieth century and has affected thousands of miles of streams. While a draining mine adit is considered the "poster child" of abandoned mineland issues, these placer sites continue to present unique challenges to land managers and others in interested in fisheries and stream restoration. TU staff Pam Elkovich and Rob Roberts will describe their successes and lessons learned while trying to address these enduring scars on the landscape.

Abstract id# 5386

"Removing a Dam, Restoring a River: The Story of Milltown, Montana"

Diana Hammer, EPA

Abstract id# 4815
Start Time: 5:00 AM
Defining Aquatic Resource Baseline Conditions for Mining Projects - the Why, What, Where, and When of Data Collection

Dudley Reiser, PhD, R2, Redmond, WA

Abstract id# 4824
Start Time: 5:40 AM
Baseline, Pre-Mine Development and Mine Operation Aquatic Monitoring, 1993-2010; An Illustration of How Long-Term Data Are Used to Track Response of Aquatic Systems for An Open Pit Copper Mine In Central Arizona

William J. Miller, PhD, Miller Ecological Consultants, Inc., Fort Collins, CO

Abstract id# 5378
Start Time: 6:00 AM
Sue Who? Navigating Liability Issues for Good Samaritan Clean-Ups

Elizabeth Russell, Trout Unlimited, Boulder, CO

Abstract Text:
Over a hundred years of hardrock mining in the western United States has left a legacy of water and soil contamination that threaten the health of the land, water and communities throughout the region. Today over 40% of western headwater streams are impacted by mine pollution, and coldwater fisheries are particularly at risk. Since 2004, Trout Unlimited has been one of the conservation groups leading the way on Good Samaritan mine cleanups. We believe that addressing pollution stemming from abandoned mines is one of the most important, yet least addressed problems facing western watersheds. However, Good Samaritan efforts to clean up abandoned mines have been stymied by liability issues that are often difficult to understand and even harder to overcome. This presentation will

discuss both Clean Water Act and CERCLA liability involved in mine cleanups, as well as potential solutions available to Good Samaritans who hope to conduct a mine cleanup. We will highlight two of TU's mine reclamation efforts in Colorado as case studies for how, and how not, to make cleanups successful.

Abstract id# 6181
Start Time: 6:20 AM
Teaching Alaska's Miners about Alaska's Fisheries

Stephen T. Grabacki, GRAYSTAR Pacific Seafood, Ltd., Anchorage, AK